

**FINAL**  
**Explanation of Significant Differences**  
Fairchild Air Force Base (Craig Road Landfill; LF002)  
USEPA ID: WA9571924647, OU-1  
**Spokane, Washington**

Contract FA8903-14-C-0011

October 2016

Revision 00

Prepared for:  
AFCEC/CZRW



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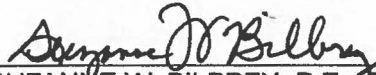
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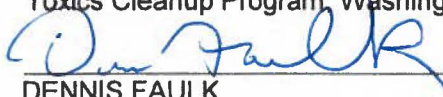
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## Acronyms and Abbreviations

%.....	percent	ISCO .....	in situ chemical oxidation
µg/L.....	micrograms per liter	MCL .....	maximum contaminant level
µg/L <sup>3</sup> .....	micrograms per cubic meter	MIP .....	membrane interface probe
AFB.....	Air Force Base	MTCA.....	Model Toxics Control Act
amsl .....	above mean sea level	NCP .....	National Oil and Hazardous Substances Pollution Contingency Plan
ARAR.....	applicable or relevant and appropriate requirement	NDA .....	Northeast Disposal Area
ASIL .....	acceptable source impact level	NOC.....	notice of construction
bgs.....	below ground surface	NPL.....	National Priorities List
CERCLA .....	Comprehensive Environmental Response, Compensation, and Liability Act	OU .....	operable unit
CERCLIS .....	Comprehensive Environmental Response, Compensation, and Liability Information System	PAL .....	project action level
CFR .....	Code of Federal Regulations	PP .....	Proposed Plan
COC.....	chemical of concern	PVC .....	polyvinyl chloride
CUL.....	cleanup level	RA-O .....	remedial action-operations
CVOC .....	chlorinated volatile organic compound	RAO .....	remediation action-objectives
DNAPL.....	dense non-aqueous phase liquid	RC.....	response complete
ERP-O.....	Environmental Remediation Program Optimization	RI .....	remedial investigation
ESD .....	Explanation of Significant Differences	ROD.....	Record of Decision
EW .....	extraction well	RW .....	remediation well
FFA .....	Federal Facilities Agreement	SAIC .....	Science Applications International Corporation
FS .....	feasibility study	SARA .....	Superfund Amendments and Reauthorization Act
GAC.....	granular activated carbon	SDA .....	Southwest Disposal Area
GETS .....	groundwater extraction and treatment system	SDWA .....	Safe Drinking Water Act
gpm.....	gallons per minute	SVE.....	soil vapor extraction
HRS .....	hazard ranking system	TCE.....	trichloroethylene
IC .....	institutional controls	UFP-QAPP.....	Uniform Federal Policy Quality Assurance Project Plan
ID .....	identification	U.S.....	United States
		USAF .....	United States Air Force
		USC .....	United States Code
		USEPA.....	United States Environmental Protection Agency
		VOC .....	volatile organic compound
		WAC .....	Washington Administrative Code
		WDOE.....	Washington Department of Ecology

## 1.0 INTRODUCTION

### 1.1 Statement of Purpose

This document presents an Explanation of Significant Differences (ESD) for the Record of Decision (ROD) for the Craig Road Landfill (LF002) Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) Identification (ID) WA9571924647 Operable Unit (OU)-1 at the Fairchild Air Force Base (AFB), 12 miles west of Spokane, Washington (**Figure 1**).

This ESD was prepared in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) §§ 300.435(c)(2)(i) and 300.825(a)(2). This document was also prepared consistent with United States Environmental Protection Agency (USEPA) guidance (USEPA, 1999).

The ROD for LF002 was issued by the USAF, the USEPA Region 10, and the WDOE on February 13, 1993 (USAF, 1993). An ESD is prepared when differences or changes in the remedial action significantly change; however, they do not fundamentally alter the remedy selected in the ROD with respect to scope, performance, or cost. This ESD provides for modification of the remedy to optimize contaminant mass removal, decrease the time to achieve response complete (RC), and reduce life cycle costs. Specifically, the components of the remedy modifications include the following:

- 1) Reinstate soil vapor extraction (SVE) as a remedy to be implemented in tandem with the Groundwater Extraction and Treatment System (GETS). SVE was initially part of the 1993 selected remedy for trichloroethylene (TCE) but was removed under the 1995 ESD based on information and technologies available at that time; however, pilot studies completed in 2011 and 2012 and follow-on operations through 2014 have demonstrated that SVE is a cost-effective approach to optimize TCE mass removal. SVE will be performed in the source areas in existing or new wells. The remedy component is necessary to increase mass removal rates and decrease life cycle costs. Additional description and justification is provided in **Sections 3.1 and 4.0**.
- 2) Expand the GETS to extract groundwater from new or existing wells located in source areas. These wells will be pumped in addition to the existing extraction wells (EWs) located on the downgradient margin of the site. The remedy component is necessary to lower groundwater levels in the source area to expose TCE media below the static groundwater level for SVE and to optimize dissolved phase removal by pumping higher TCE concentration groundwater. Additional description and justification is provided in **Sections 3.2 and 4.0**.

### 1.2 Lead and Support Agencies

The lead agency, the United States Air Force (USAF), is responsible for compliance with the CERCLA process, the ROD, and implementation/maintenance of remedial action-operations (RA-O). The USEPA's role is to provide regulatory oversight and to review and comment on plans and reports. The USEPA has authority to make decisions regarding clean-up in cases where the Air Force and USEPA do not agree on remedy selection. The Washington Department of Ecology (WDOE) is a supporting agency and has participated in scoping and evaluation of remedial data for the site. The WDOE is participating in accordance with a Federal Facilities Agreement (FFA).

### **1.3 Administrative Record**

This ESD and other relevant documents will become part of the Administrative Record file pursuant to the NCP§ 300.825(a)(2). Public notice of the ESD will be published in *The Spokesman-Review*, Spokane, Washington.

This ESD will be made available to the public for review at the following locations:

#### **ADMINISTRATIVE RECORD**

Spokane Falls Community College Library  
W. 3410 Fort George Wright Drive  
Spokane, WA 99204

The Spokane Falls Community College Library is open during normal school hours; detailed updates can be found on the library's website: <http://library.spokanefalls.edu/Hours.aspx>

#### **USAF ADMINISTRATIVE RECORD**

Available online at: <http://afcec.publicadmin-record.us.af.mil/Search.aspx>

## 2.0 SITE BACKGROUND

LF002 was a former disposal location for Fairchild AFB and was used for general purpose landfilling and is now comprised of three inactive waste disposal areas. Municipal and industrial wastes were buried in two of the areas (Northeast Disposal Area [NDA] and the Southwest Disposal Area [SDA]) and demolition debris from runway reconstruction was deposited on the ground surface in the third disposal area (Rubble Area). This section provides a brief summary of site history, geology and hydrogeology, nature and extent of contamination, RAOs, the selected remedy, and completed remedial actions for LF002.

### 2.1 Site Setting

LF002 is located approximately 1 mile east of Fairchild AFB on 100 acres owned and operated by USAF. Property ownership is not anticipated to change in the foreseeable future. The downgradient area east and northeast of the Site is primarily for light industrial and gravel quarry use; however, there is a small mobile home park adjacent to the northeast corner of the Site. Municipal wells for the city of Airway Heights are located approximately 1 mile east of the Site. The land use of the surrounding area is not anticipated to change in the foreseeable future.

### 2.2 Site History

LF002 was a former disposal location for Fairchild AFB and was used for general purpose landfilling. The Site consists of three inactive waste disposal areas (**Figure 2**). Municipal and industrial wastes were buried in two of the areas (Northeast Disposal Area [NDA] and the Southwest Disposal Area [SDA]), and demolition debris from runway reconstruction was deposited on the ground surface in the third disposal area (Rubble Area).

The 6-acre NDA was actively used as the main solid waste disposal area for the base from the late 1950s until the early 1960s. A standard trench-and-fill disposal method was used. The area was given a natural soil cover and graded following disposal activities. Disposal depths are estimated to exceed 30 feet below ground surface (bgs; Science Applications International Corporation [SAIC], 1993).

The 13-acre SDA was active from the late 1960s until the late 1970s. General waste types reportedly disposed of in this area included municipal and industrial wastes and construction and demolition debris; suspected disposal items are thought to include such items as solvents, dry-cleaning filters, paints, thinners, and coal ash. Disposal practices consisted of fill-and-cover in the topographical low areas, possibly with some excavation. The SDA was given a soil cover and then overlaid in some areas with concrete blocks and asphalt from base runway replacement activities. Disposal depths are estimated to exceed 25 feet bgs (SAIC, 1993).

The 20-acre Rubble Area was active in the late 1950s and received surface disposal of construction debris from runway work performed during base conversion. This area has not been identified as a source of environmental contamination and is not discussed further in this document.

Beginning in 1984, several methods of investigation were used for contaminant source and risk identification including record searches, interviews, and site inspections. In 1987, the USEPA scored the Fairchild AFB (four Waste Areas) using their Hazard Ranking System (HRS). As a result of the HRS scoring, Fairchild AFB, including LF002, was added to the National Priorities List (NPL) in March 1989.

Between 1986 and 1991, a Remedial Investigation (RI; SAIC, 1992) was completed to characterize and delineate LF002 contamination; TCE was identified as the primary chemical of concern (COC) with groundwater concentrations above Washington's Model Toxics Control Act

(MTCA) Method A clean up level (CUL) of 5 micrograms per liter ( $\mu\text{g/L}$ ).

The RI Report for LF002 was released to the public in April 1992. The Feasibility Study (FS) and Proposed Plan (PP) were released on August 10, 1992. The remedy of hydraulic containment was formalized in the ROD signed in 1993. See **Section 2.7** for a description of remedial actions completed at LF002.

### **2.3 Geology and Hydrogeology**

Most of the geological and hydrogeological data for LF002 was obtained from drilling and logging associated with the RI (SAIC, 1992), supplemental borehole testing (Engineering Science, 1993a), GETS installation (Engineering Science, 1993b), and SVE and in situ chemical oxidation (ISCO) pilot testing (CH2MHill, 2014). These data indicate that the Site is underlain by approximately 15 to 70 feet of alluvial sand and gravel sediments overlying basalt bedrock. The basalt bedrock consists of two basalt flows (Basalt A and Basalt B) separated by a sedimentary interbed (Interbed A) of lacustrine clay deposits. Basalt A is the uppermost basalt flow group and ranges from approximately 50 to 120 feet thick. The surface of Basalt A generally slopes gently downward to the northeast. Beneath the SDA, the top of Basalt A was found to range from an elevation of 2,380 to 2,365 feet above mean sea level (amsl; CH2MHill, 2014). In the NDA, the top of Basalt A was found to range from an elevation of 2,370 to 2,347 feet amsl. In general, the upper portions of basalt bedrock were more weathered and fractured and generally became increasingly competent (fewer fractures) with depth (Engineering Science, 1993a). Interbed A is approximately 10 to 15 feet thick and occurs at a depth of approximately 150 feet bgs. Basalt B is at least 70 feet thick below the site (SAIC, 1992).

The alluvial sand and gravel deposits thicken to the east of LF002. A gravel quarry is located in this area. Drilling and surface geophysics completed during the RI (SAIC, 1992) identified a deep, incised channel that had cut and filled as much as 250 feet of sand and gravel into the basalt bedrock to the east. Within the channel, the Basalt A has been eroded away and does not exist.

Groundwater near LF002 occurs within both alluvial and basalt bedrock aquifers (SAIC, 1992). The alluvial and Basalt A aquifers generally form a single, unconfined to semi-confined hydrogeologic unit, termed the alluvial/Basalt A aquifer. The Interbed A serves as a confining unit between Basalt A and the Basalt B below. A lower confined aquifer is present in Basalt B beneath the confining Interbed A unit. Quarterly RAO groundwater monitoring (CH2MHill 2012; Bhate, 2015) indicated that groundwater flow in both aquifers generally is to the east-northeast.

### **2.4 Nature and Extent of Contamination**

The primary COC at LF002 is TCE in groundwater. Based on membrane interface probe (MIP) borings and groundwater and vapor sampling between 2009 and 2012 (CH2M Hill, 2014), the source areas for TCE appear to be relatively small areas within the upper 50 feet of the Basalt A aquifer under the NDA and SDA.

The extent and distribution of TCE as of March 2015 is shown on **Figure 3**. In general, the extent of TCE above the Maximum Contaminant Level (MCL) and MTCA limit of 5  $\mu\text{g/L}$  is approximately 200 to 400 feet northeast of the property line in the north and approximately 1,000 feet east/northeast of the property line in the south (MW-82). Downgradient of the NDA wells, TCE concentrations in MW-78 have been below the CUL since 1996 and have been below the CUL since 1999 in MW-80. Downgradient of the SDA, MW-77 has been below the CUL since 2010. However, TCE concentrations in MW-141 (2,700 feet northeast) and MW-118 (2,000 feet downgradient) have remained above the MCL since monitoring began in 1995. Two off-site wells, MW-118 and MW-141 (depicted on **Figure 2**), have TCE concentrations that have remained above the MCL/MTCA limit since monitoring began in 1995.

## **2.5 Remedial Action Objectives**

The LF002 RAOs, as listed in the ROD (USAF, 1993), are:

1. To prevent consumption of groundwater exceeding federal MCLs (5 µg/L for TCE) by area residents;
2. To restore contaminated groundwater in the upper aquifer to levels that are safe for drinking;
3. To prevent further migration of contaminated groundwater across the site boundary and to the lower aquifer;
4. To minimize the migration of contaminants from the fill material to the groundwater; and
5. To prevent exposure to contaminants within subsurface soil and debris.

## **2.6 Applicable or Relevant and Appropriate Requirements**

This ESD does not require new or modified Applicable or relevant and appropriate requirements (ARARs) for the LF002, from what was previously listed in the ROD (USAF, 1993).

## **2.7 Selected Remedy**

The selected remedy, as outlined in the ROD (USAF, 1993) for restoring contaminated groundwater at LF002, consists of both source control and groundwater control actions. The source control was intended to minimize migration of contaminants from the fill material to the underlying groundwater and prevent direct exposure to contaminated subsurface soil and debris. The groundwater control actions are intended to prevent further migration of contaminated groundwater across the site boundary and to prevent consumption by area residents of groundwater which exceeds CULs. The remedy complies with the federal and state ARARs for the LF002 that were identified in the ROD and listed in **Section 2.5**. The major components of the selected remedy, as listed in the ROD, include:

- Capping the northeast and southwest disposal areas at the landfill;
- Installing an active SVE and treatment system in each capped area;
- Extracting contaminated groundwater from the upper aquifer at the landfill boundary through utilization of a GETS and treating by air stripping and granular activated carbon (GAC); treated groundwater will be returned to the site groundwater via infiltration trenches downgradient of LF002;
- Monitoring off-site water supply wells within the off-site portion of the plume and providing point-of-use treatment and/or alternative water supply if needed in the future;
- Monitoring groundwater in upper and lower aquifers; and
- Implementing institutional controls (ICs).

In September 1993, a post-ROD treatability study was conducted to provide engineering information needed to design the SVE system (Engineering Science, 1993). In summary, the study determined that an SVE system would not be effective at LF002. During that time, it was believed that two primary sources of groundwater contamination associated with the LF002 existed: the fill material and a dense non-aqueous phase liquid (DNAPL) in groundwater. It was thought that DNAPL could be expected to be the predominant source for ongoing contamination, particularly with the leaching of contaminants from the fill material minimized by capping the disposal areas. Hence, the additional costs of implementing an SVE system to remediate the contaminant vapors in the fill material would not provide a significant decrease in overall risk from contaminants.

Subsequently, an ESD was issued in 1995 to document the elimination of the SVE system as a portion of the remedy. The changes were agreed upon by the USEPA, the WDOE, and the USAF. The Affirmation of Statutory Determination listed in the 1995 ESD for the removal of the SVE system included the following:

*The modifications to the proposed remedial actions will continue to utilize permanent solutions and treatment to the maximum extent practicable for the site. Based on the information gained during RD from the treatability study and groundwater monitoring, it has been determined by the Air Force, USEPA, and Ecology that the elimination of the SVE system will not affect the ability of the remedy to achieve cleanup levels. Additionally, the remedy will remain protective of human health and the environment, comply with federal and state ARARs, and is cost-effective.*

## **2.8 Completed Remedial Actions**

A summary of the completed remedial actions at LF002 is provided below:

- 1991: Limited GETS system operation begins in order to provide hydraulic containment of the on-site plume.
- 1994-1995: An air stripping unit was added to the GETS.
- 1994-1995: Engineered landfill caps consisting of composite soil, geotextile, and 30-millimeter polyvinyl chloride (PVC) liner were installed over the NDA and SDA. Currently, the caps remain functional, are intact, and require minimal maintenance.
- 1995: Full-time operation of the GETS system was initiated.
- 1995: RA-O groundwater monitoring program was implemented for on-site and off-site monitoring wells constructed in the alluvium/Basalt-A, Basalt B, and alluvial channel aquifers.
- 2006: GETS periodically idled to allow groundwater to flood the Basalt A under the NDA and SDA, resulting in a temporary increase in mass removal.
- 2008: An Environmental Remediation Program Optimization (ERP-O) evaluation recommended that SVE be reconsidered as a potential remedy.
- 2009-2011: SVE pilot tests performed in the SDA and NDA verified that SVE is an effective method of TCE mass removal. Remediation wells (22 wells in the SDA and 14 in the NDA) were constructed as multi-purpose wells that could be used for SVE, ISCO, or additional monitoring wells.
- 2011-2012: Because of the success of the pilot test, continued operation of the SVE systems was recommended. With WDOE concurrence full scale, SVE operation began in February 2011. The USEPA concurred with continued operation of the SVE system in October 19, 2012, correspondence.
- 2012-2014: The GETS was operated on a limited basis in response to residual permanganate and chromium concentration increases from the ISCO pilot test. ISCO appears to have been successful at destroying significant TCE mass; however, the cost of ISCO is considerably higher than for SVE, and ISCO has left residual permanganate and chromium concentrations above regulatory limits.
- Fall 2014: SVE was suspended because of high groundwater levels during limited GETS operation, high groundwater levels at that time, and to allow for an ESD to bring this remedy under compliance with the ROD. SVE operations will remain offline until approval of this ESD.
- 2012-2014: The GETS was operated on a limited basis in response to residual permanganate and chromium concentration increases from the ISCO pilot test. On-going SVE operations, with concurrence from WDOE, continued until Fall of 2014.

Fairchild AFB has implemented ICs per the ROD and the Fairchild AFB Land Use Control Plan in order to prevent potential exposure to contaminated soil, wastes, or groundwater at LF002. The ICs implemented for OU-1, as listed in the Third CERCLA Five-Year Review, include:

- Prevent disturbance to the landfill caps, except as necessary for authorized activities;
- Prevent drilling of new wells except for MWs authorized by regulators;
- Protect existing monitoring wells;
- Prevent use of contaminated groundwater for drinking water purposes;
- Prevent unauthorized soil excavations at the site;
- Notify USEPA and WDOE prior to any development or redevelopment of the landfill site to ensure that the integrity of the engineered cap will not be jeopardized;
- Ensure that in the event of a transfer of the property to another entity, these restrictions will transfer with the land;
- Prevent drilling of new wells except for monitoring wells authorized by regulators (off-site IC);
- Protect existing monitoring wells (off-site IC); and
- Prevent use of contaminated groundwater for drinking water purposes (off-site IC).

### 3.0 BASIS FOR SIGNIFICANT DIFFERENCE

Since 1995, operation of the GETS has demonstrated it is effective technology at hydraulic control and plume containment; however, over time the efficiency of the GETS at source mass removal has been declining. Based on concentration trends at LF002, the time to remediation has been reported to range from 23 to 63 years (CH2M Hill, 2014). Significant differences in the remedy are proposed to enhance and augment mass removal so that the time to remediation and life cycle costs are decreased. The proposed modification to the remedy are to 1) expand the GETS to additionally extract groundwater from source areas in addition to the EWs located on the downgradient margin of the site, and 2) reinstate SVE as a remedy to be implemented in tandem with the GETS. Both changes will be on the existing GETS operations. Additional descriptions of the remedy modifications are provided in **Section 4.0**.

#### 3.1 Reinstatement of SVE

SVE was initially part of the 1993 selected remedy in the ROD but was removed via an ESD in 1995 because it was not considered to be effective for treating deeper potential DNAPL-impacted fractured bedrock; however, SVE at LF002 was reconsidered by the USAF in 2008, and has been subsequently demonstrated to be an effective and efficient remedy based on the following:

- MIP and soil gas investigations and groundwater TCE concentration responses from GETS cycling indicate that a significant mass of contaminants is present within the upper 30 feet of the Basalt A beneath the SDA and NDA.
- Pilot tests completed in the SDA in 2009 and in the NDA in 2010 indicated that SVE is an effective technology for TCE mass removal at both locations. Because of the successes of the pilot tests, WDOE concurred with a recommendation to continue “full scale” operation of the SVE system beginning in 2011. The USEPA concurred with continued SVE operation in 2012. SVE was suspended because of high groundwater levels at the time and to allow for an ESD to bring this remedy in compliance with the ROD.
- Between 2010 and 2012, SVE operations yielded average TCE mass removal rates of 63 pounds per year, and during the same period an average TCE removal rate of 36 pounds per year from the GETS.
- SVE data from 2011 to 2013 demonstrated that TCE vapor yields increased with lower groundwater elevations. For example, (as shown on **Graph 1**) in Remediation Well (RW)-2, vapor yields were less than 1 pound per quarter when the groundwater elevation was higher than 2,366 feet amsl and increased to 21.6 pounds per quarter when the groundwater elevation was 2,356 feet amsl. Using average air extraction rates and TCE vapor concentrations from low-water periods (first and second quarters, 2011 and 2012); TCE vapor yields of 75 pounds per year appear likely if groundwater drawdown is maintained. Additional vapor yield improvements are possible by increasing groundwater drawdown further, increasing air extraction rates and extraction locations.
- A 2014 Treatability and Testing Report (CH2M Hill, 2014) concluded that SVE provided the most cost-effective TCE mass removal technology between GETS, SVE, and ISCO. Using an anticipated SVE mass removal rate of 63 to 75 pounds per year, and annual operating costs of \$40,000 reported from the 2014 CH2M Hill Soil Vapor Extraction and In Situ Chemical Oxidation Treatability Testing Report, the cost per pound (using an average of 70 pounds per year) by SVE is anticipated to be \$600 compared to \$9,500 for GETS alone (see **Table 1**). Cost assumptions and calculations are provided in **Appendix A**.

Graph 1  
 TCE Vapor Phase Removal Rates vs. Groundwater Elevations at RW-2

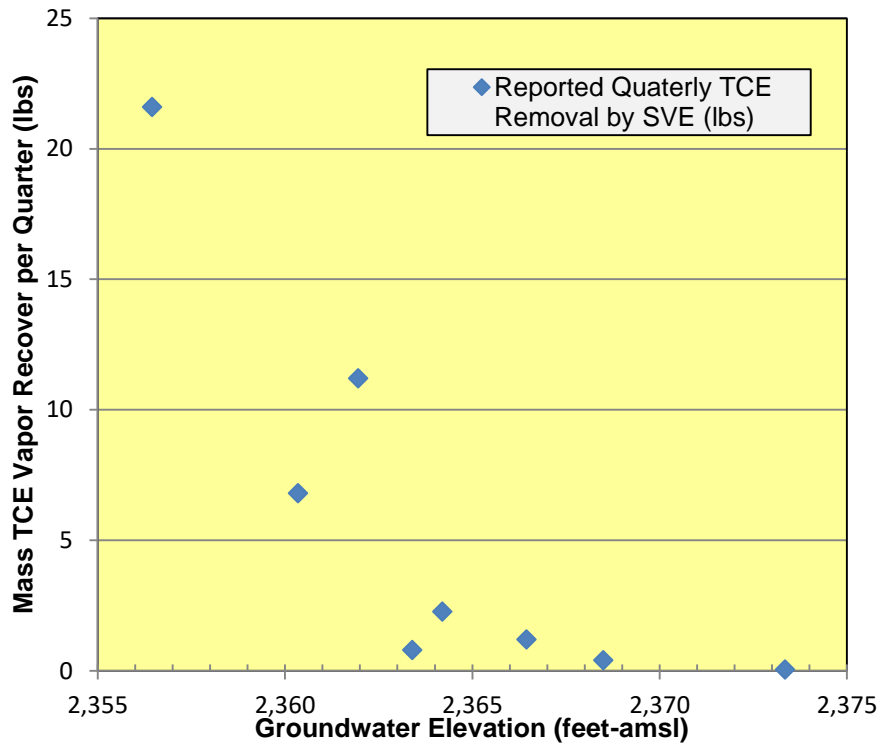


Table 1 Summary of TCE Removal Rates and Cost Efficiencies by Applicable Technology

Technology	TCE Removal Rate (pounds per year)	Annual Operating Cost	Cost per Pound of TCE Removed
2015 Current unmodified GETS	5.6	\$175,000 <sup>(1)</sup>	\$31,300
Anticipated SVE	67 to 98 <sup>(2)</sup>	\$40,000 <sup>(1)</sup>	\$410 to 600
Anticipated Expanded GETS (see <b>Section 3.2</b> )	77 to 103 <sup>(3)</sup>	\$181,000 <sup>(4)</sup>	\$1,760 to 2,300
Anticipated SVE and Expanded GETS	140 to 200	\$221,000	\$1,100 to 1,500

Notes:

- 1) Reported from CH2M Hill, 2014
- 2) Assumed 80 percent (%) to 120% of 2012 SVE mass removal rate
- 3) See **Appendix A** for mass removal estimates
- 4) See **Appendix A** for cost calculations

### 3.2 GETS Expansion (Source Area Extraction)

The GETS currently extracts groundwater from wells located at the SDA and NDA downgradient margins, which are 300 to 1,000 feet from source areas. Consequently, dispersion and dilution substantially decrease TCE concentrations relative to the source areas. In March 2015, the

average and maximum TCE concentrations were 34 and 192 µg/L, respectively, in the EWs, but were 95 and 1,040 µg/L, respectively, in the SDA and NDA RWs.

In late 2012, pumping at EW-6, EW-9, EW-10, and EW-14 was suspended to prevent extracting ISCO residuals (chromium and remaining permanganate). Total flow rates dropped from 59 million gallons per year (Mgal/yr) in 2011 to approximately 15 Mgal/yr in 2013 and 2014. The loss of higher TCE concentration water from the deactivated wells also decreased the influent TCE concentration. The lower flow and influent concentration resulted in a sharp decline in TCE mass removal from 17.6 pounds/year (lbs/yr) in 2011 to 3.7 (lbs/yr) in 2014.

Using protocols developed in the LF002 Site-Specific Uniform Federal Policy Quality Assurance Plan (UFP-QAPP; Bay West, 2015), pumping at EW-6, EW-9, and EW-14 and limited pumping at EW-10 was resumed in July 2015. This resulted in an extraction increase to 43.7 Mgal/yr but only a slight increase in annual mass removal to 5.6 pounds because of relatively low concentrations at the EWs.

The anticipated GETS expansion will extract from existing or new wells completed within LF002 that have not been previously utilized by the GETS. Dissolved phase TCE mass removal will be optimized by increasing both TCE influent concentrations and total flow rates. For example, pumping the three 4-inch diameter wells that are either the highest or near the highest TCE concentrations would yield an average concentration of 260 µg/L (NDA-8, NDA-9, NDA-12, RW-10, RW-13, RW-14; based on March 2015 sample results) compared to the flow weighted average TCE concentrations of 23.4 µg/L in the existing GETS. Pumping data from these wells suggest that they may be capable of 50 gallons per minute (gpm) or more. Conservatively, assuming a flow rate of 10 gpm each for 60 gpm total from the expanded wells, the overall flow rate could be increased by 150 percent (%) (to an average of 170 gpm), compared to the average 2011 rate (110 gpm). The combined effect of higher concentrations and flow rates would increase mass recovery by three-fold (see **Table 1**).

The GETS expansion is anticipated to augment SVE by dewatering the Basalt A and exposing more of the formation to air phase removal. As discussed in **Section 3.1**, TCE vapor concentrations increased as the groundwater elevations dropped. During previous SVE operations, groundwater elevation occurred from distant pumping wells and seasonal groundwater fluctuation. By having the points of extraction in the source area, dewatering of the Basalt A can be better maintained and increased from previous efforts via the existing GETS.

Cost of the GETS expansion would be primarily the capital expense of purchasing and installing new submersible pumps, controls, and above-grade piping. These costs plus 10 percent (%) per year repair and replacement costs annualized over 5 years only increase the GETS annual costs by 3% (see **Table 1** and **Appendix A**). Since cost of operating the expanded GETS remains essentially unchanged, the cost per pound of TCE removal would drop from \$31,300 to between \$1,760 and 2,300. Adding cost and removal rates for the SVE would further decrease the unit costs to between \$1,100 and 1,500 per pound of TCE (**Table 1**).

### 3.3 Reduced Time to Remediation

The time to remediation for the modifications described in this ESD was approximated by comparing TCE concentration trend responses to past changes in TCE removal rates. The metric for evaluating concentration response is the average TCE concentration in EW-2 through EW-11, and EW-14 (EW TCE concentrations). Since remediation began in 1995, there have been four periods with significant changes in TCE mass removal rates. These periods are described below, and a summary of the TCE mass removal and TCE concentration responses for each of these periods is provided in **Table 2**. A plot of the EW TCE concentrations and concentration trend half-lives are presented in **Graph 2**.

- Between 1995 and 2005, the GETS operated continuously, and the average TCE concentration half-life was 5.1 years. Near the end of this period (2004-2005) the average annual TCE removal rate by the GETS was 22 lbs./yr. This is the baseline for comparison to the other subsequent removal rates.
- Between 2006 and 2009, the GETS was cycled seasonally basis to periodically flood the upper Basalt A and increase mass removal rates. Near the end of this period (2008-2009) the average annual TCE removal rate was 77 lbs./yr. (350% of baseline), and the EW TCE concentration half-life decreased by about half (49% of baseline).
- Between 2010 and 2012, SVE and ISCO pilot tests were performed. After the third quarter of 2012, the pumping at several of the EWs was suspended to mitigate extracting residual ISCO reactants and products. The average TCE mass removal rate for 2010-2012 was 176 lbs./yr. (1,000% of baseline), and the average EW TCE half-life decreased to about 20% of baseline. The relative proportion of the TCE removal by GETS, ISCO, and SVE are provided in **Table 2**.
- Between 2013 and mid-2015, several of the EWs remained off-line. The mass removal rate in 2014 was 2 lbs./yr. A trend for average EW TCE trend has yet to develop for this operational period.

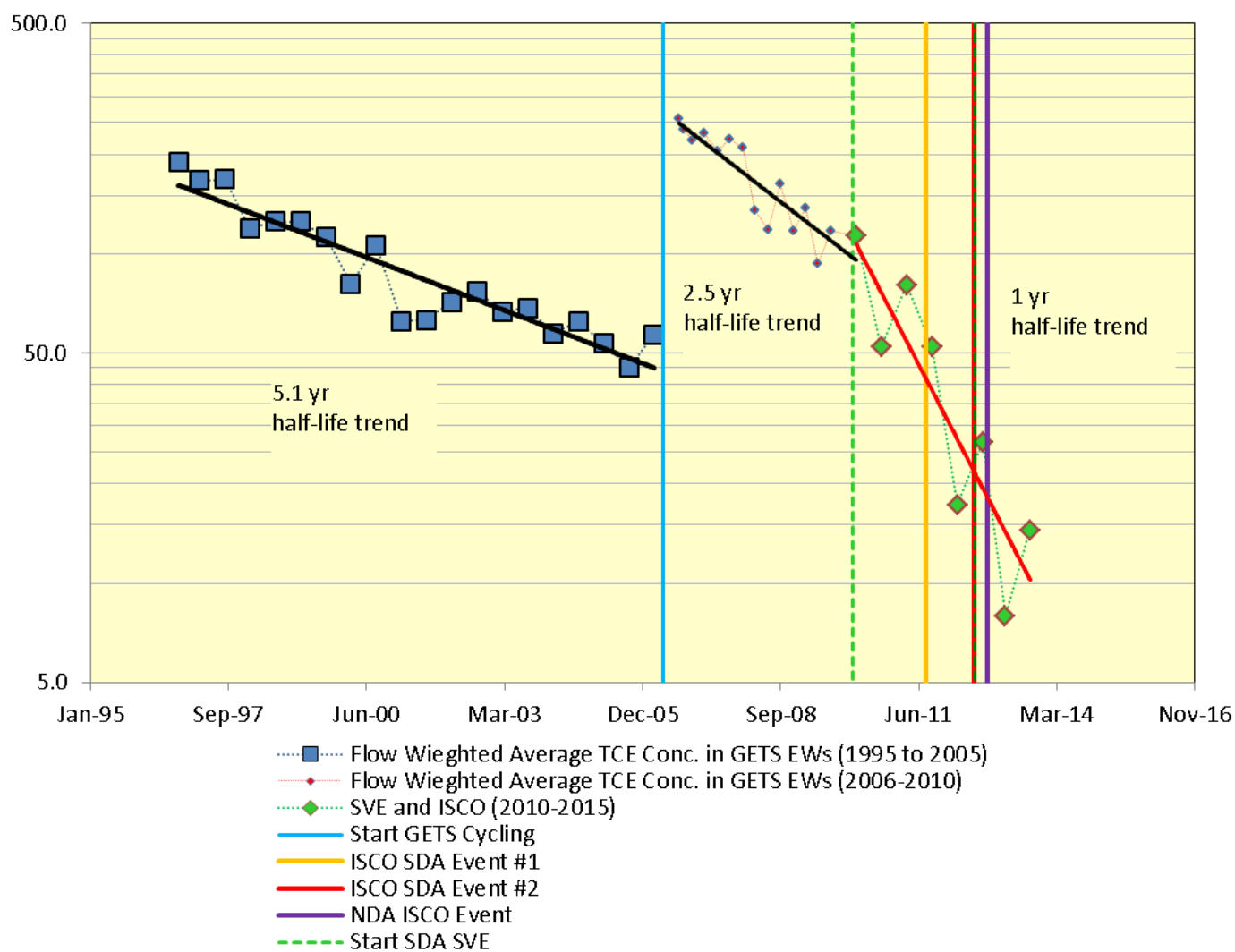
**Graph 3** shows the relationship between mass removal and average EW TCE concentrations relative to the baseline. From this relationship it is estimated that for the anticipated removal rates for the ESD modifications the average EW TCE half live would be 13 to 25% of baseline. Using the highest March 2015 TCE result (1,040 µg/L at NDA-9) and the pre 2006 half-life trend, the baseline time to remediation was estimated to be 39 years (**Appendix A**). This is assumed to be the time to remediation without the modifications presented in this ESD. The anticipated time to remediation for the ESD modifications is between 5 and 10 years. The estimated change in life cycle costs in reducing the time to remediation is approximately \$4.6 to 5.7 million

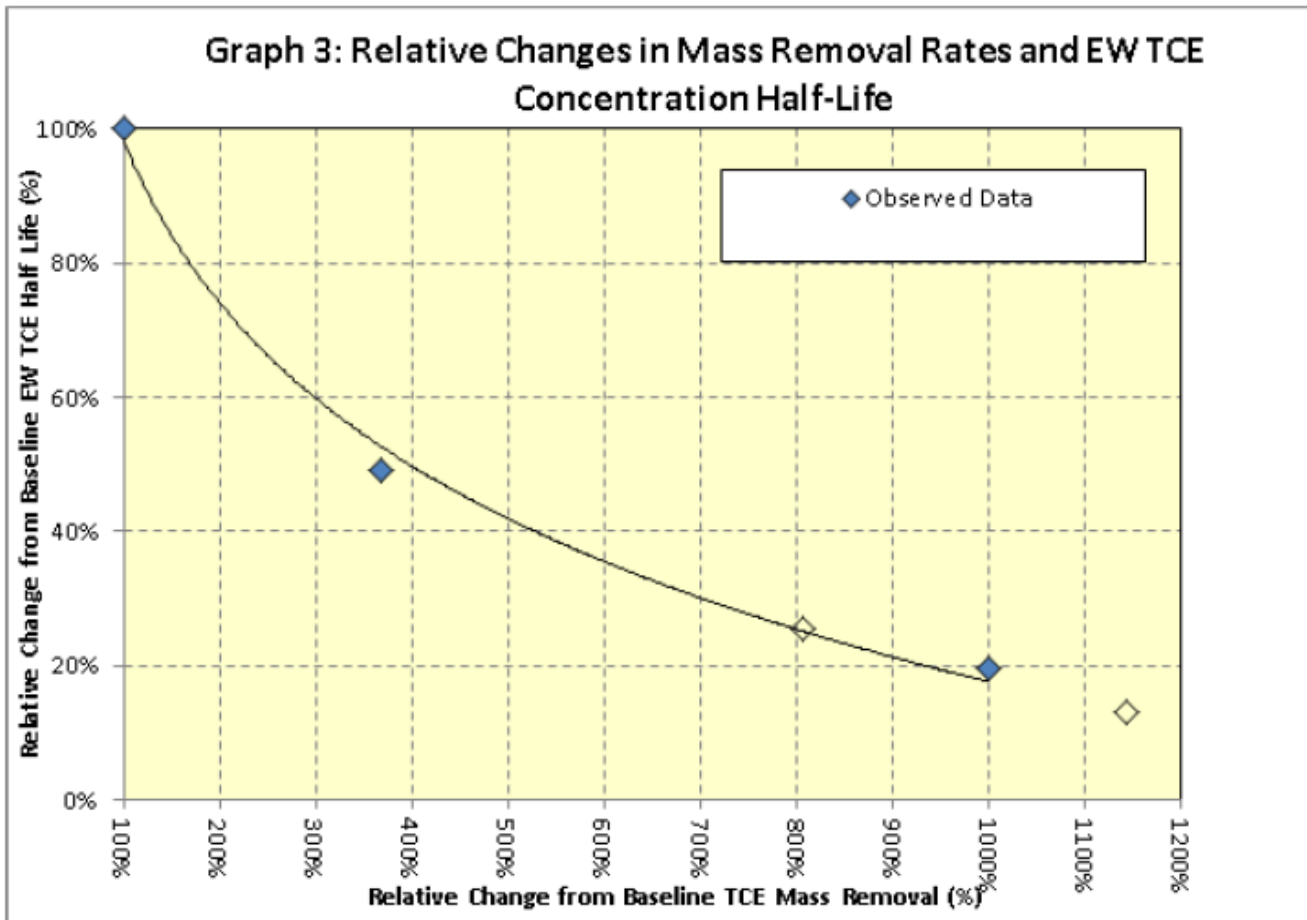
**Table 2 Mass Removal and EW TCE Concentration Responses**

Period	TCE Removal			EW TCE Concentration Responses		
	Rate (lbs./yr.)	Removal Processes	Relative to Baseline	Observed Half-Life in Graph 2 (yrs.)	Relative to Baseline	Time to Remediation (yrs.) <sup>1</sup>
1995-2005 Continuous GETS	22 (2004-2005)	100% GETS	100%	5.1	100%	39
2006-2009 Cycled GETS	77 (2008-2009)	100% GETS	350%	2.5	49%	19
2010-2012 ISCO & SVE Pilot tests	210 (2011-2012)	11% GETS 63% ISCO 27% SVE	950%	1.0	20%	8
Minimal GETS 2013-2014	2 (2014)	100% GETS	9%	**	--	
Projected	140 to 200	50% GETS 50% SVE	650% to 910%		13% to 25%	5 to 10

1) Half-life at rate presented assuming a starting TCE concentration of 1,040 µg/L (maximum in March 2015).

**Graph 2**  
**Flow Weighted Average TCE Concentrations in the GETS Extraction Wells**





### 3.4 Summary of Justifications

The following is a summary of the justifications for the system modifications as discussed above. Additional specifics of the modifications are provided in **Section 4.0**.

- SVE is an effective technology at removing TCE mass at LF002 and has a unit contaminant removal cost much less than the existing GETS;
- The GETS expansion will enhance SVE by dewatering the Basalt A and exposing the formation to vapor phase removal;
- The GETS expansion will improve dissolved phase TCE mass removal rates and improve removal cost efficiency;
- The GETS expansion will retain pumping at the EWs to maintain hydraulic control and plume capture; and
- The combined SVE and expanded GETS is anticipated to increase TCE mass removal rates 645% to 910% from baseline and decrease time to remediation from 39 years to between 5 and 10 years. GETS life cycle cost savings are anticipated to decrease by between 4.6 and 5.7 million.

## 4.0 DESCRIPTION OF SIGNIFICANT DIFFERENCES

### 4.1 Background

As discussed in **Section 2.6**, the ESD issued in 1995 documented the elimination of the SVE system as a portion of the remedy. Subsequent treatability studies and pilot testing have demonstrated that SVE should be reinstated in conjunction with expanded GETS to most effectively remove TCE from the aquifer.

### 4.2 Significant Differences

The significant differences between the remedy as presented in the ROD and the modified remedy include the following:

- Operation of the GETS with plume capture and hydraulic control at the EWs along the downgradient site margin will continue. The modified remedy will not adversely affect plume capture and control.
- The GETS will be expanded to include groundwater extraction in or near TCE source areas from existing or new wells. The purpose of the source area groundwater extraction is to increase TCE dissolved phase removal rates and to dewater the Basalt A to expose the formation for SVE. The extraction is anticipated to be performed using submersible pumps, but other pumping methods may be employed as needed. The groundwater from the source area wells will be plumbed to the GETS for treatment and discharge. Protocols developed in the UFP-QAPP for chromium and permanganate will be employed to mitigate discharge of these constituents above Project Action Levels (PALs). The number and location of source areas wells pumped and the rates of extraction will be determined based on cost, effectiveness, and flexibility of use. This modification will increase efficiency of dissolved phase TCE mass removal and optimize TCE mass removal by SVE.
- SVE will be reinstated as a remedy and will be performed in tandem with the expanded GETS system. SVE will be performed at existing or new wells in or near TCE source areas. It is anticipated that the air extraction will be performed using one or more rotary vane blowers, but other air extraction methods may be used based on cost, effectiveness, and flexibility of use. The blower or air extraction units will be connected to the wells via temporary above-grade piping to allow maximum flexibility. The number and location of wells to be extracted and number of sizes of blower units will be determined based on cost, effectiveness, and flexibility of use. Air exhaust from the SVE will be treated via GAC filtration to meet the LF002 Notice of Construction (NOC). The modification to reinstate SVE will increase TCE mass removal rates, decrease time to remediation, and decrease life cycle costs.
- No changes have been made to the RAOs, CULs, and points of compliance in this ESD, and remain as selected and documented in the ROD.
- Performance objectives, metrics, monitoring and decision criteria are provided in the LF002 Site-Specific UFP-QAPP Addendum (anticipated to be completed in the Fall of 2016). This document also includes criteria for discontinuing active remediation. Design criteria, system specifications and operational monitoring will be provided in the Remedial Design-Remedial Action Work Plan (anticipated to be completed in the Fall of 2016).

## **5.0 REGULATORY AGENCY ACCEPTANCE**

The USEPA has reviewed this document and concurs with this ESD. The WDOE has also been provided a copy of this document for review. WDOE decided not to participate in this CERCLA review and has not provided any comments.

## 6.0 STATUTORY DETERMINATIONS

This ESD revises the selected remedy for LF002 included in the 1993 ROD and subsequent 1995 ESD to reinstate SVE and expand the GETS. It is consistent with CERCLA §121 (42 United States Code [USC] §9621) and the NCP (40 Code of Federal Regulations §300). The revised remedy revision is protective of human health and the environment, complies with Federal and State ARARs identified in the ROD, is cost-effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable for the site. The modified remedy satisfies CERCLA §121.

The modified remedy uses treatment to reduce the mobility, toxicity or volume of TCE as a principle element of the modified remedy.

The remedy will continue to be subject every five years to protectiveness reviews per CERCLA § 121(c).

## **7.0 PUBLIC PARTICIPATION AND COMPLIANCE**

When this ESD is finalized, a Notice of Availability and a brief description of the ESD will be published in the Spokesman-Review, Spokane, Washington, in accordance with the NCP §300.435(c). Additionally, this ESD will be made available to the public and become part of the Administrative Record.

## **8.0 REFERENCES**

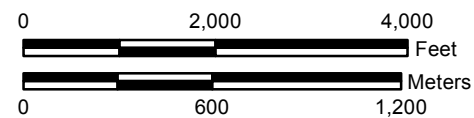
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- United States Air Force, 1995. EPA Explanation of Significant Differences: Fairchild Air Force Base (4 Waste Areas) EPA ID WA9571924647 OU 01 Spokane Washington February 10 1995.
- USEPA, 1999. A Guide to Preparing Superfund Proposed Plans, Records of Decision and Other Remedy Selection Decision Documents, EPA 540-R-98-031, OSWER 9200.1-23P, July 1999.

## **Figures**

## Fairchild AFB, WA

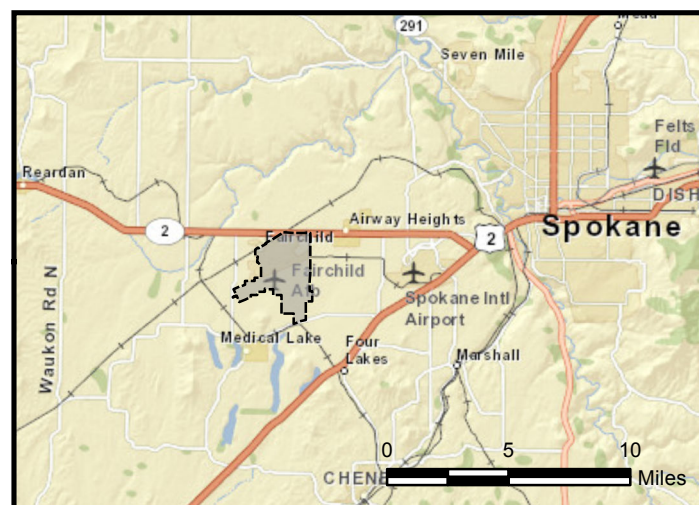


Map Projection: NAD 1983 UTM Zone 11N, Meters  
Basemap: ESRI World Imagery WMS

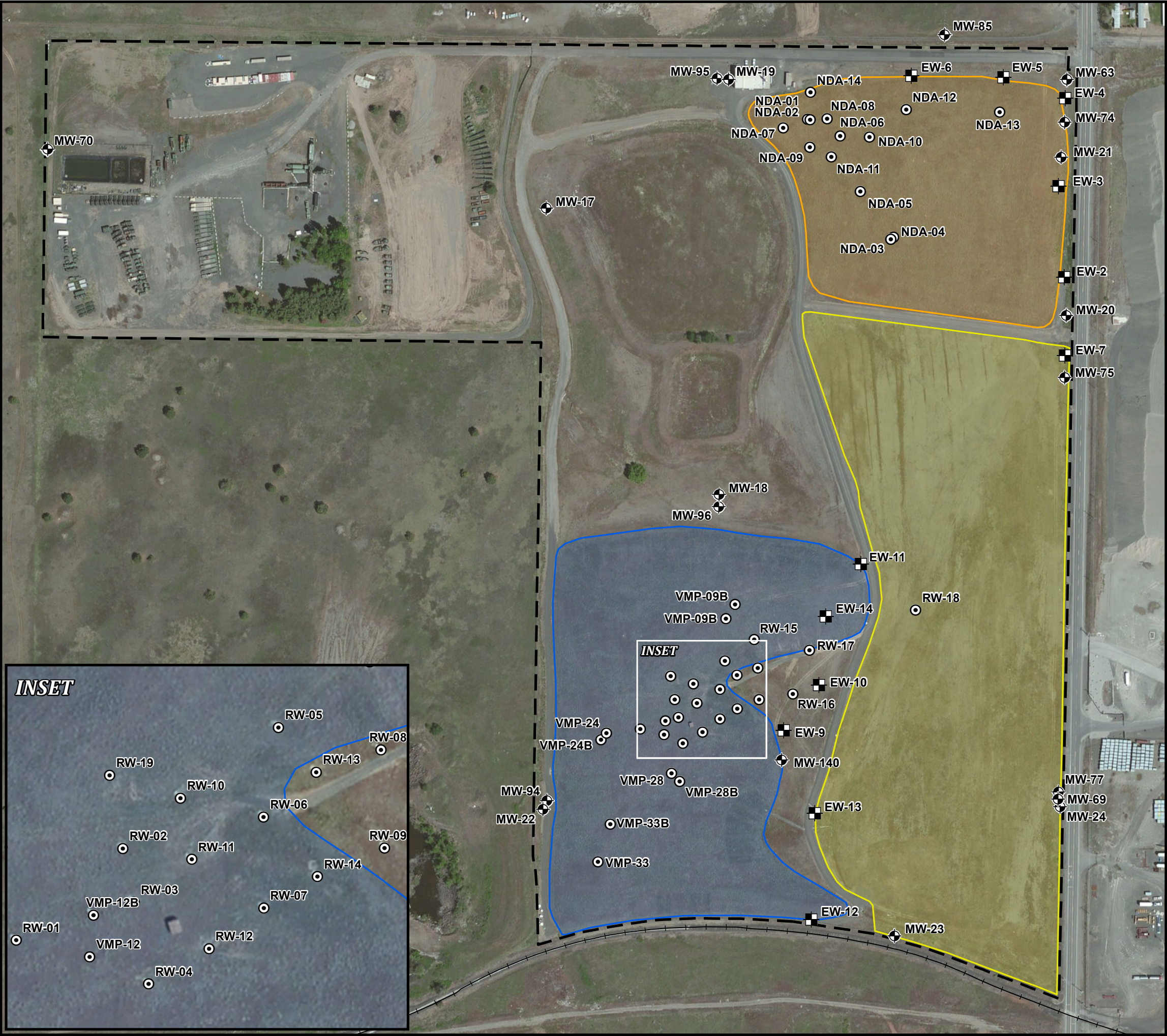


## Installation Boundary

Craig Road Landfill (LF002) Site Boundary



Y:\Clients\US\_AIR\_FORCE\_CIVIL\_ENGINEER\_CENTER\Fairchild\_AFB\MapDocs\LF002\J130130 FIG 2 Craig Road Landfill LF002 Site Map.mxd

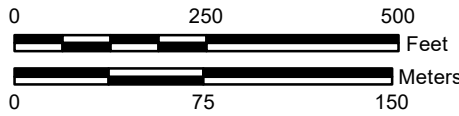


**Figure 2**  
**Craig Road Landfill (LF002)**  
**Site Map**

Fairchild AFB, WA



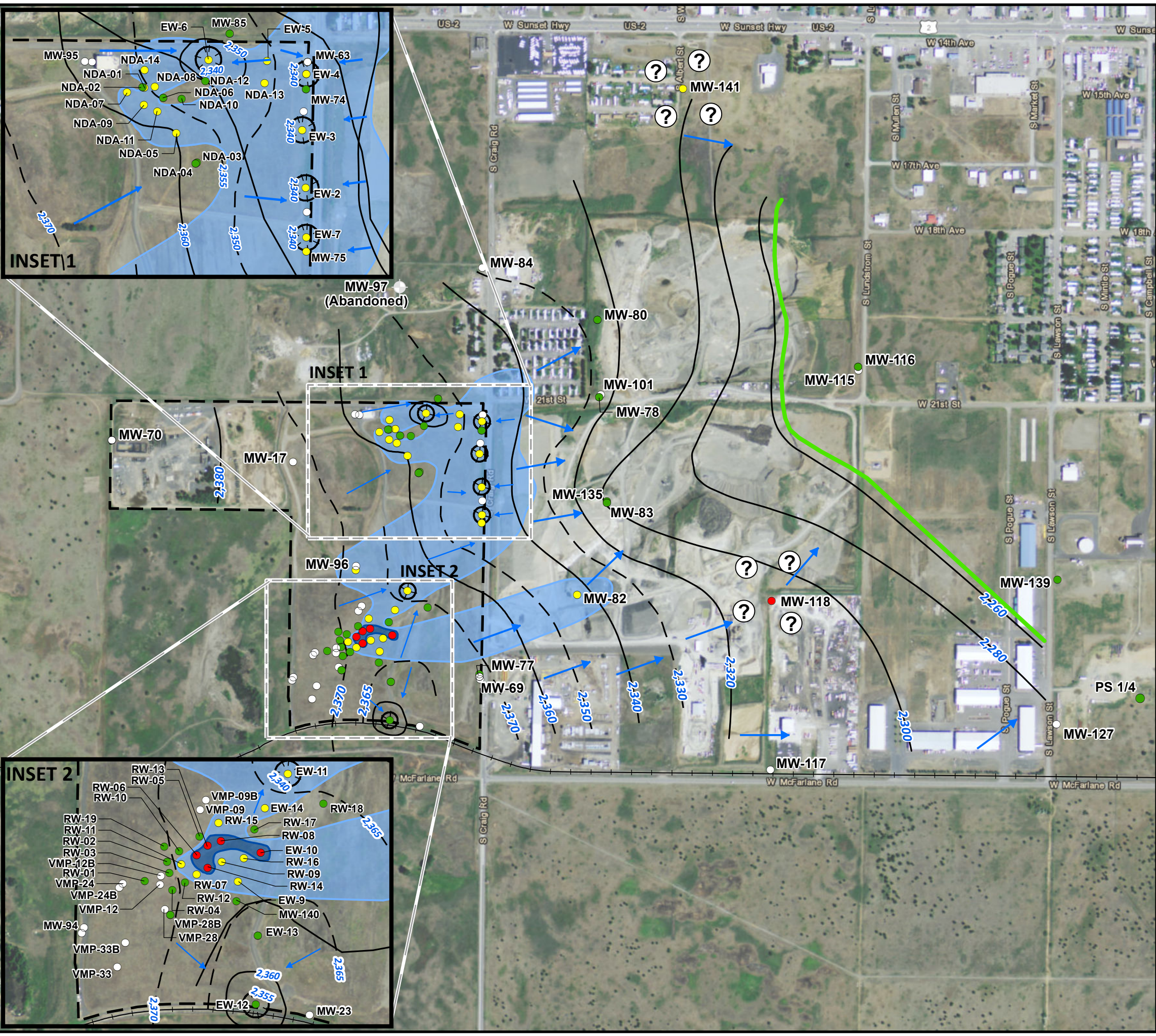
Map Projection: NAD 1983 UTM Zone 11N, Meters  
Basemap: ESRI World Imagery WMS



- Extraction Well
- Monitoring Well
- Remediation Well
- Railroad
- Craig Road Landfill (LF002) Site Boundary
- Northeast Disposal Area (NDA)
- Southeast Disposal Area (Rubble Area)
- Southwest Disposal Area (SDA)



Y:\Clients\US\_AIR\_FORCE\_CIVIL\_ENGINEER\_CENTER\Fairchild\_AFB\MapDocs\LF002\U130130 FIG 3 LF002 TCE Plume Map March 2015.mxd

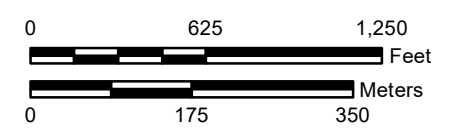


**Figure 3**  
**Craig Road Landfill (LF002)**  
**TCE Plume Map, March 2015**

Fairchild AFB, WA



Map Projection: NAD 1983 UTM Zone 11N, Meters  
Basemap: ESRI World Imagery WMS



- Groundwater Contour Line
- Supplemental Contour Line
- Groundwater Flow Direction
- Basalt A Extent Line
- Railroad
- Craig Road Landfill (LF002) Site Boundary
- TCE Plume (>100 µg/L)
- TCE Plume (>5 µg/L)

**TCE Concentrations**

- Not Sampled
- <5 µg/L
- 5 - 100 µg/L
- >100 µg/L



## **Appendix A**

### **Assumptions and Calculations**

# Appendix A Assumptions and Costs

## A) MASS REMOVAL ESTIMATES

<u>i) Existing GETS</u>	Total Annual 2015 Exaction	Millions of Gallons		Millions of Liters	
		43.68		165	
	Fraction of Total Flow (current configuration)	Mar 2015 TCE Conc. µg/L		Annual Mass Extraction (lbs)	
Locaiton					2011 Annual Extraction Rate
EW2	8.6%	7.62		0.2	
EW3	0.3%	11.5		0	$M = Q * \% * C * 2.2 \times 10^{-3} \text{ } \mu\text{g/lb}$  M= Annual TCE mass removal (lbs) Q= Annual extraction volume (Millions of liters) % = Fraction of flow per well C= TCE Concentration µg/L $2.2 \times 10^{-3}$ conversion of µg to lbs x 1 million
EW4	0.1%	19.4		0	
EW5	32.7%	5.1		0.6	
EW6	5.0%	9.52		0.2	
EW7	15.8%	30.3		1.7	
EW9	6.9%	82.9		2.1	
EW10	0.7%	192		0.5	
EW11	0.1%	11.3		0	
EW12	24.7%	0		0	
EW13	0.0%	0		0	
EW14	5.1%	15.8		0.3	
Source Area Wells	0.0%	500			
<b>TOTAL</b>	<b>100.0%</b>			<b>5.6</b>	

<u>ii) Expanded GETS</u>	Total Annual Exaction (Assume 2011 Rates)	Millions of Gallons		Millions of Liters	
		Low	High	Low	High
		65.68	87.68	248	331
Location	Anticipated configuration	Mar 2015 TCE Conc. µg/L		Annual Mass Extraction (lbs)	
EW2	5.3%	26	26	0.8	1
EW3	0.2%	12	12	0	0
EW4	0.1%	9.9	9.9	0	0
EW5	19.0%	6.8	6.8	0.7	0.9
EW6	4.7%	11	11	0.3	0.4
EW7	9.2%	34	34	1.7	2.3
EW9	4.9%	43	43	1.2	1.5
EW10	4.9%	130	130	3.5	4.7
EW11	4.9%	12	12	0.3	0.4
EW12	0.0%	0	0	0	0
EW13	0.0%	0	0	0	0
EW14	4.9%	20	20	0.5	0.7
Source Area Wells	48.0%	260	260	68.1	90.9
<b>TOTAL</b>	<b>106.1%</b>			<b>77.1</b>	<b>102.8</b>

2015 annual extraction rate 22-44 Mgal/yr from source area wells.

## Appendix A Assumptions and Costs

### vi) SVE Mass Removal

	Lbs/yr	
	Low	High
2012 Total SVE	65.6	98
	80% of 2012 rate	120% of 2012 rate
Total baseline mass removal	5.6	lbs/yr
Total mass removal	142.7	201 lbs/yr

### B) COST CALCULATIONS

i) Annual GETS Operation	\$175,000	From CH2MHILL, 2014
ii) Annual SVE Operation	\$40,000	From CH2MHILL, 2014

#### iii) Expanded GETS

Capitol Costs	Unit cost	Units	Cost	
Pumps (2HP)	\$2,000	6	\$12,000	Assumed # of pumping locations for cost
Piping & Controls			\$2,000	
Installation			\$6,000	
TOTAL			\$20,000	
Annualized over 5 yrs			\$4,000	
Repairs & maintenance (10% capitol costs)			\$2,000	
GETS O&M			\$175,000	
TOTAL Annual Expanded GETS			\$181,000	(3% increase)

### C) COST PER POUND

	TCE Mass Removal Per Year (lbs)		Annual Cost	Cost per Pound TCE Removed	
	Low	High		Low	High
Curent GETS	5.6		\$175,000	\$31,300	
SVE	65.6	98	\$40,000	\$600	\$407.00
Expanded GETS	77.1	102.8	\$181,000	\$2,300	\$1,761.00
TOTAL	142.7	201.2	\$221,000	\$1,500	\$1,098.00

### D) TIME TO REMEDIATION (from Graph 4)

From Graph 2 TCE concentration trends are exponential and are defined by the following equation:

$$C_t = C_o \cdot \text{EXP}(R \cdot T)$$

$C_t$  = concentration at Time = t;  $C_o$  = starting concentration

R = exponential rate; T = Time

When  $C_t/C_o = 1/2$  then this can be rearranged to:

$$-0.69/HL = R \text{ (where HL = Half Life and } -0.69 \text{ is the natural log (ln) of } 1/2)$$

Time to remediation ( $T_r$ ) occurs when  $C_t/C_o = C_{mcl}/C_o$  ( $C_{mcl} = C$  at MCL); Then:

$$T_r = HL \cdot \ln(C_{mcl}/C_o) / 0.69$$

Set  $C_o$  to 1040 ug/L (highest TCE Concentration in March 2015) and  $C_{mcl} = 5$  (the MCL for TCE) and using a baseline HL of 5.1 (Graph 2), then the **baseline  $T_r = 39.5$**   
Cutting the HL by 13% to 25% (Graph 3) the  $T_r$  becomes **5 to 10 years**

### E) LIFE CYCLE COST CHANGES

GETS Operation	39 yrs			Annual operating cost x yrs
	\$6,825,000			
	Low (5 yr Tr)	High (10 yr Tr)		
SVE + Expanded GETS	\$1,105,000	\$2,210,000		
<b>Difference</b>	<b>\$5,720,000</b>	<b>\$4,615,000</b>		